Using Corrosion Design Models to Accelerate the Transition of Alternatives

Craig Matzdorf
Materials Engineering Division
Naval Air Warfare Center
U.S. Navy

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE **AUG 2012**	2. REPORT TYPE	3. DATES COVERED **00-00-2012 to 00-00-2012**

4. TITLE AND SUBTITLE **Using Corrosion Design Models to Accelerate the Transition of Alternatives**	5a. CONTRACT NUMBER
	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Naval Air Warfare Center,Materials Engineering Division,22347 Cedar Point Road,Patuxent River,MD,20670**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES
ASETSDefense 2012: Sustainable Surface Engineering for Aerospace and Defense Workshop, August 27-30, 2012, San Diego, CA. Sponsored by SERDP/ESTCP.

14. ABSTRACT

15. SUBJECT TERMS

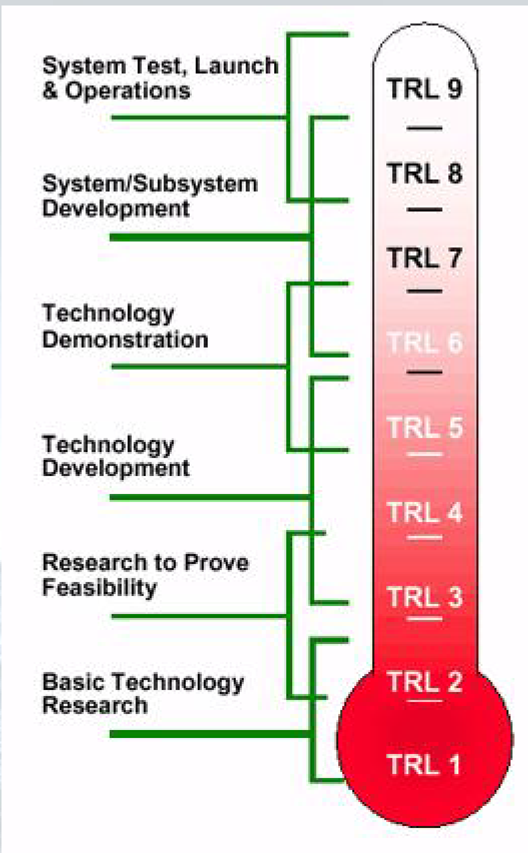
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**10**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

Agenda

- Current Time to Develop, Validate and Implement Alternatives
- Corrosion Design Models
- Potential Ways to Use Models to Speed the Process
- Other Benefits from the Models

Current Time to Develop, Validate and Implement Alternatives



Technology Readiness Level

Typical Time per interval

2- 5+ yrs

2- 3 yrs

2- 4 yrs

1- 4 yrs

2- 3 yrs

2- 4 yrs

Total Time- 11-20+ yrs

Example

TCP ~18 yrs from initial discovery to first use

- Original R&D started in ~1990
- Original Patent- 1994
- Follow on R&D- 1999-2004
- Additional Patents- 2002-2010
- Field Demos- 1999-2005+
- Licensing and qualified products- 2004-2005
- First Authorization- 2006
- First NAVAIR Implementation- 2008

Corrosion Design Models

- **Three main efforts underway to develop computational corrosion design models to aid in material selection and reduce corrosion risk during initial design**
  - GCAS: ACES program, initially supported by TACOM/Army
    - NAVAIR Phase II SBIR, modifying software to include light metals/aviation interfaces
  - Corrdesa/Elsyca: GalvanicMaster
    - ONR Phase II SBIR: program being modified for aviation weapon systems
  - Beasy/Computational Dynamics: Corrosion Technology
    - Plan to support comparison to ACES and GalvanicMaster in future

Corrosion Design Models

- **All moving to incorporate light metals, composites and other aviation materials**
- **Maturation includes effect of protective materials**
- **All depend upon DC polarization data**
  - Common method to acquire data needed- being supported through ONR Sea Based Aviation efforts

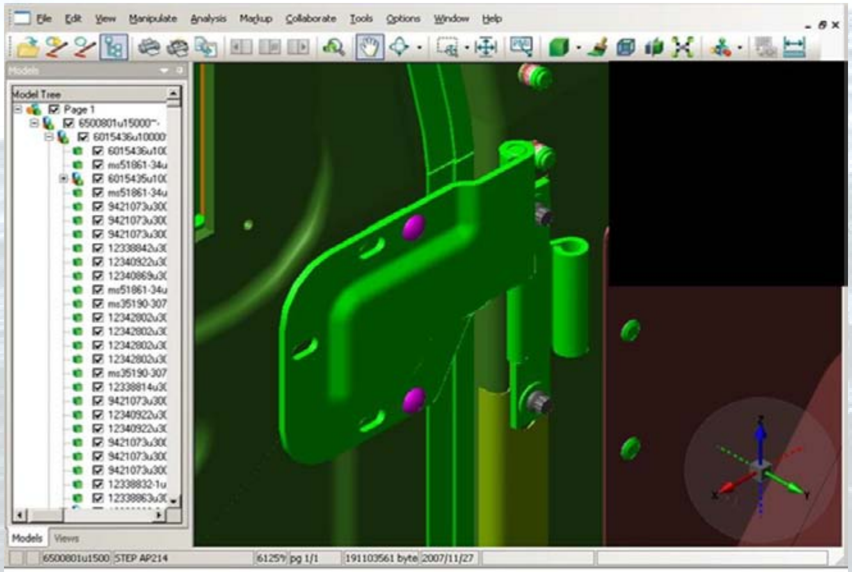
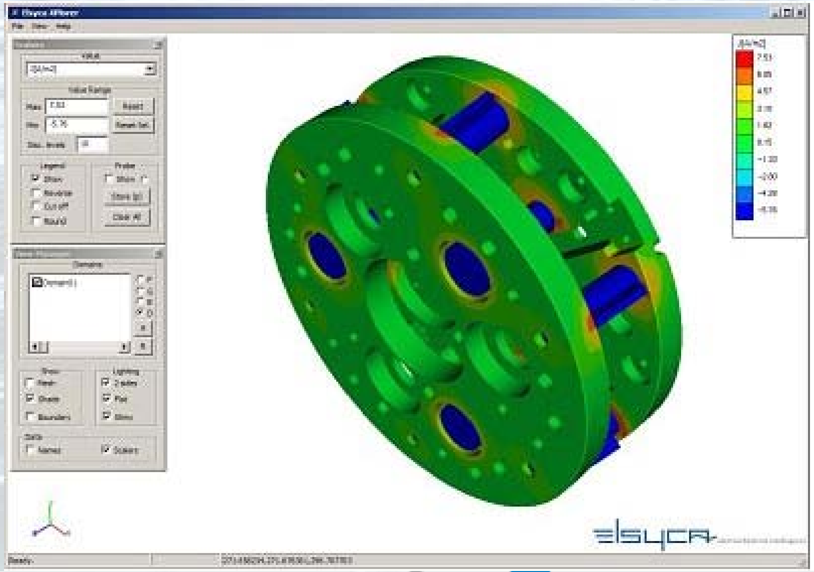


Figure 5: Zoom of Door Hinge on the Mid-Size STEP- HMMWV Model



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Potential Ways to Use the Design Models to Accelerate the Process

- **Use galvanic test assembly and DC polarization/electrochemical data to predict performance of new materials**

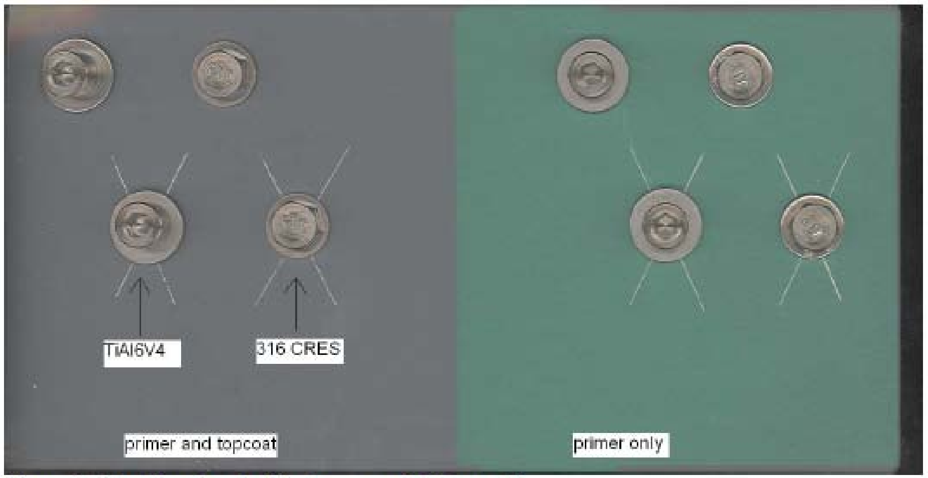
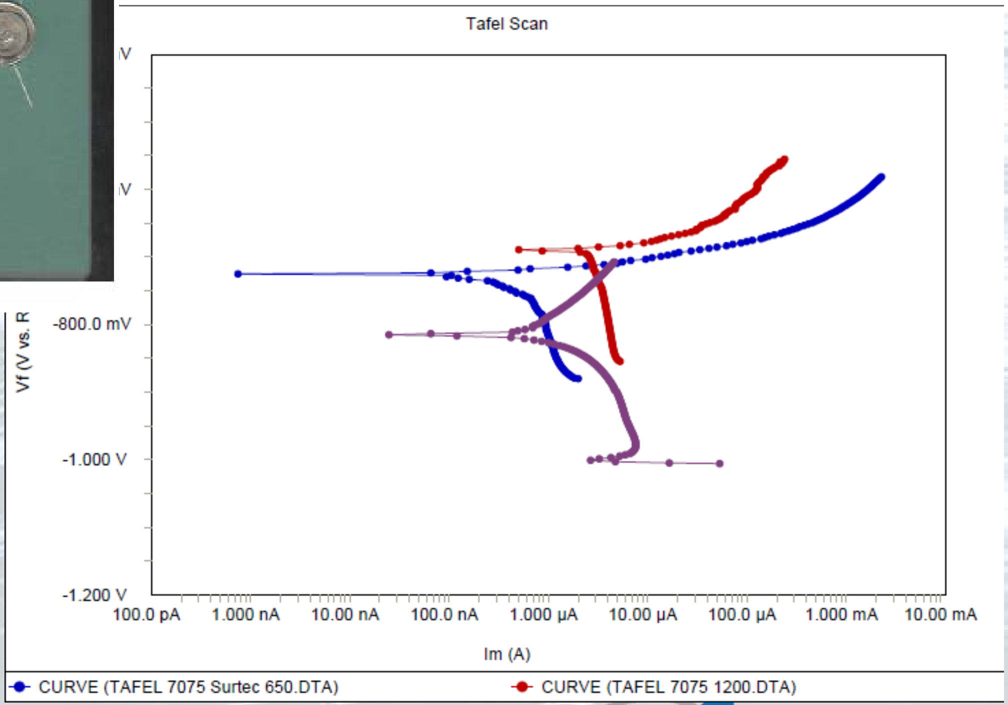


Figure 1: Coated and scribed fastener panel before testing.



Potential Ways to Use the Design Models to Accelerate the Process

- **Compare to actual performance at beach exposure site (KSC) and with accelerated cabinet tests**
- **Advantages:**
  - Allows predictions with many different substrates, coatings, and combinations of materials
  - Rapid validation using beach data
  - Potential for quicker transition from lab to weapon system testing
- **Disadvantages**
  - Immature: models themselves have low TRL and only currently account for time zero
  - Does not account for MRL
  - Unknown factors

Potential Ways to Use the Design Models to Accelerate the Process

- **Path Forward:**
  - Work with GCAS and Corrdesa through SBIRs to model NAVAIR’s galvanic assembly
  - Develop DC polarization and other data needed for individual coatings and input into models
  - Feed model actual beach, B117 and SO_2 corrosion data for a large variety of coating combinations
    - Anode/substrate: 7075-T6 and 2024-T3 aluminum
    - Cathode/fasteners: TiAl6V4 and 316 CRES
    - Aluminum surface treatement: Bare, anodized, conversion coated (various), adhesion promoters
    - Primers: Various Class C and N from MIL-PRF-23377 and MIL-PRF-85582
    - Topcoat: Various from MIL-PRF-85285
  - Repeat predict/test/validate cycle with new/unknown materials
  - Modify/improve galvanic assembly or add new types to account for 3 or 4 major interface types on aircraft (raised, countersunk, rivets, threaded, etc.)
  - Long term: Link to effect on structural life/stress corrosion cracking/corrosion fatigue

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Potential Ways to Use the Design Models to Accelerate the Process

- **Payoff/Potential Uses**
  - Acquisition: enable prediction of effect of material selection or substitution on weapon system performance
    - Life-cycle cost/maintenance impact
    - Structural life impact
  - Life Extensions: enable more accurate prediction of remaining life with current and alternative protection schemes
    - Requires the development of pitting models which link to structural degradation
    - Underway in separate projects
  - Product Qualification: enable higher quality test requirements for protective materials
    - Potentially enable less field testing before implementation
    - Encourages the development of higher performing products
  - Research and Development: enable more rapid progress through TRLs
    - Less subjective data
    - More efficient screening
    - Better feedback to product developers

Other Benefits of Models

- **Potential Use to Track Hazmat on Weapon Systems**
  - Programs already required to complete PESHE and track hazardous materials
  - Very laborious to determine impact of changing protection schemes
  - Models will be able to estimate substrate volume and surface area and coating volume and surface area, weight, and location very accurately
- **Potential to be included as a contract deliverable**
  - Potential to improve negotiations between OEM and DoD customer over design trade offs
  - Color coded visual output much more effective at conveying risk compared to showing pictures of corroding test panels, and is similar to how structural loads are predicted and communicated today
- **Potential to Simulate Aging of Weapon System over Time and Predict Maintenance Intervals**
  - Models will be able to simulate environment of asset over its life using relative corrosivity data
  - Potential to simulate damage and less effective repair of factory applied materials
  - Potential to study effect of wash and rinse intervals, basing, sheltering, etc. and tie to protection scheme life
  - May help better tailor field testing